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(54) **DEFORMABLE COMPONENT CARRIER**

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(52) **U.S. Cl.** ..... **296/21**; 296/187.03; 180/68.5

(58) **Field of Classification Search** ..... 296/187.11, 296/187.03, 204

See application file for complete search history.

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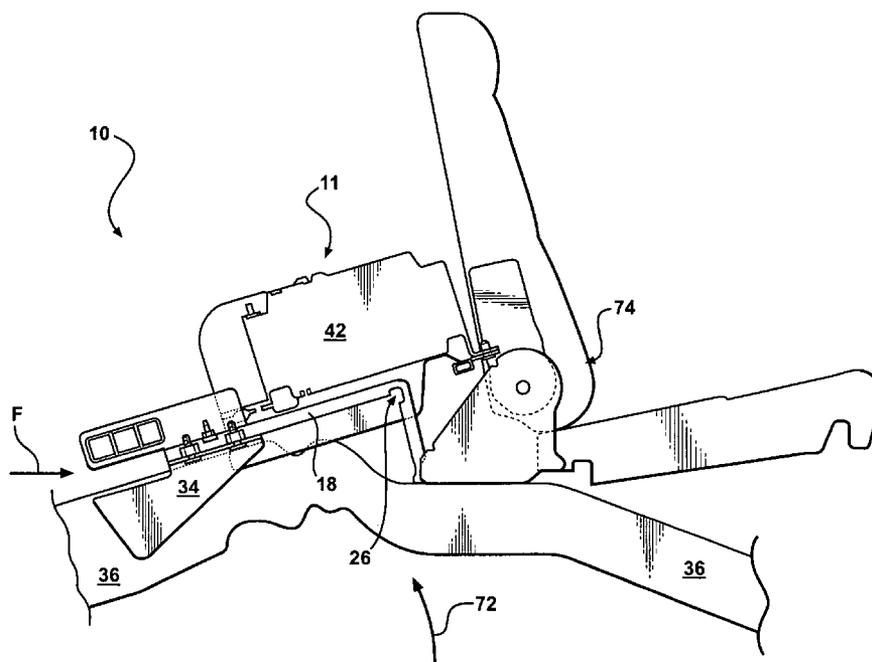
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(57) **ABSTRACT**

A carrier for use in supporting a component in a vehicle structure in accordance with the present invention includes at least a pair of side rails each having a first end and an opposed second end. The first and second ends of the side rails are attached to the vehicle structure, and each side rail includes a predetermined bending location at a predetermined location between the first and second ends. The component is adapted to be attached to the side rails intermediate the predetermined bending location and the first end. The side rails are operable to bend about the predetermined bending location when an impact load is applied to the first end of the side rails.

**19 Claims, 4 Drawing Sheets**



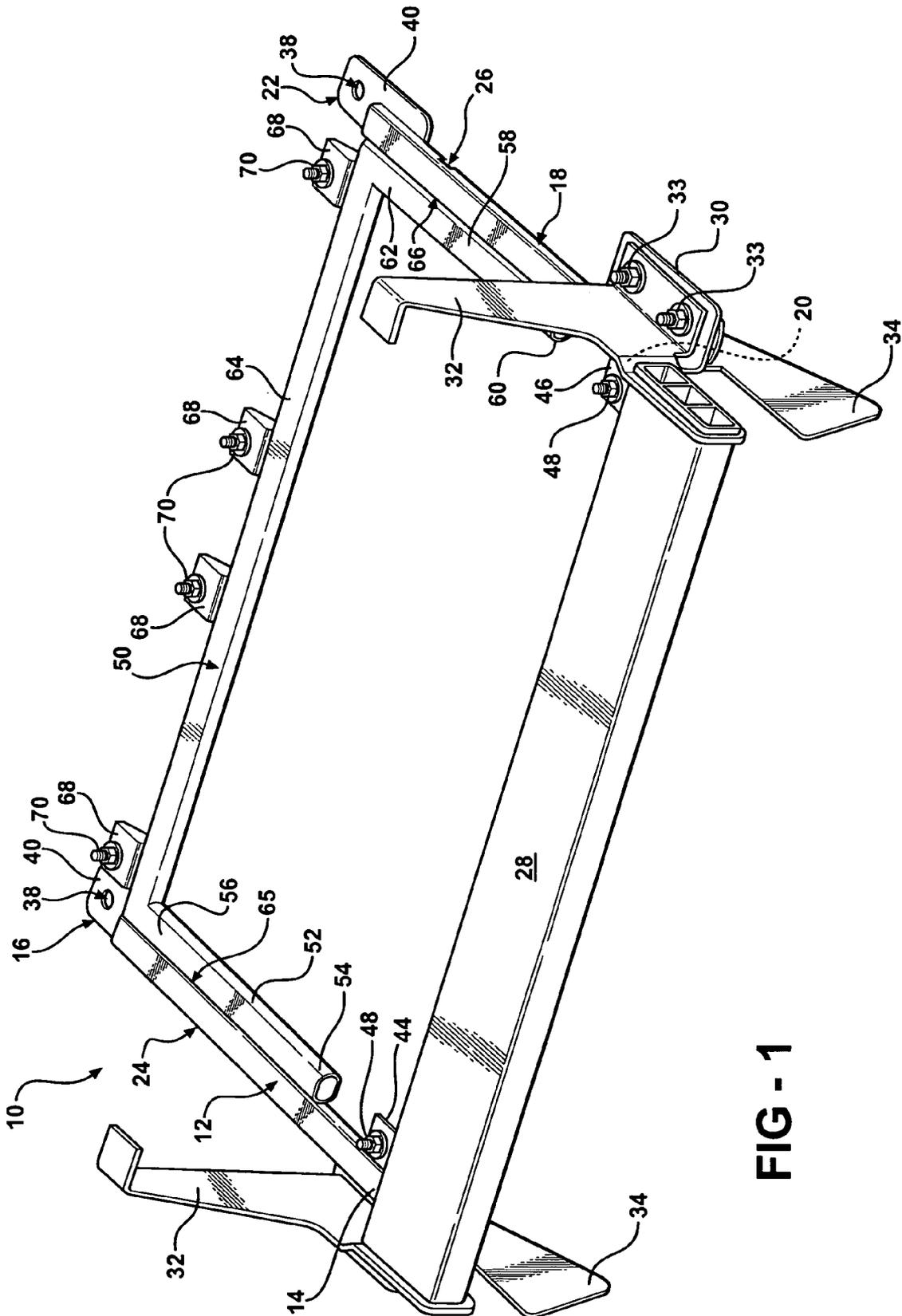


FIG - 1

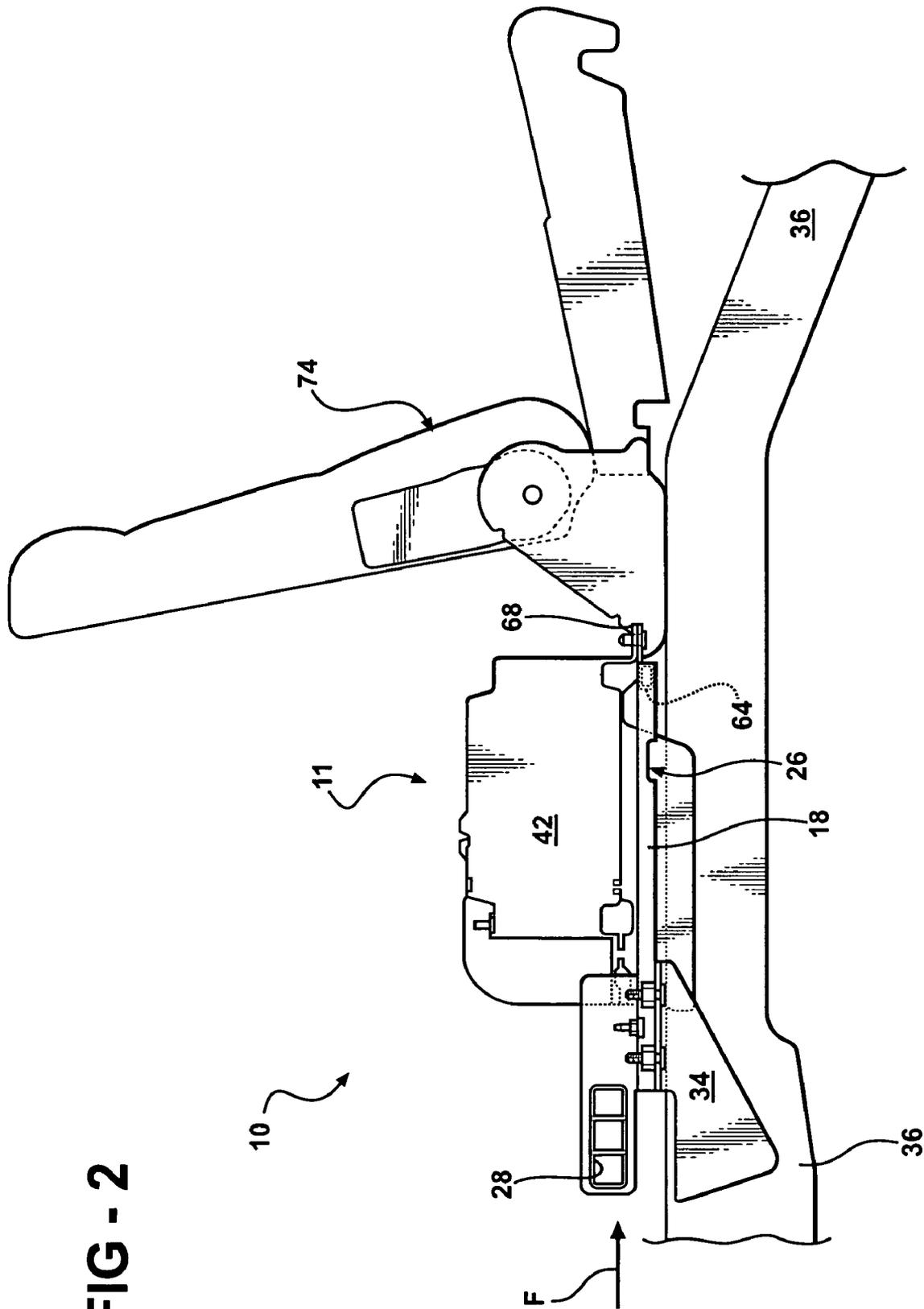


FIG - 2

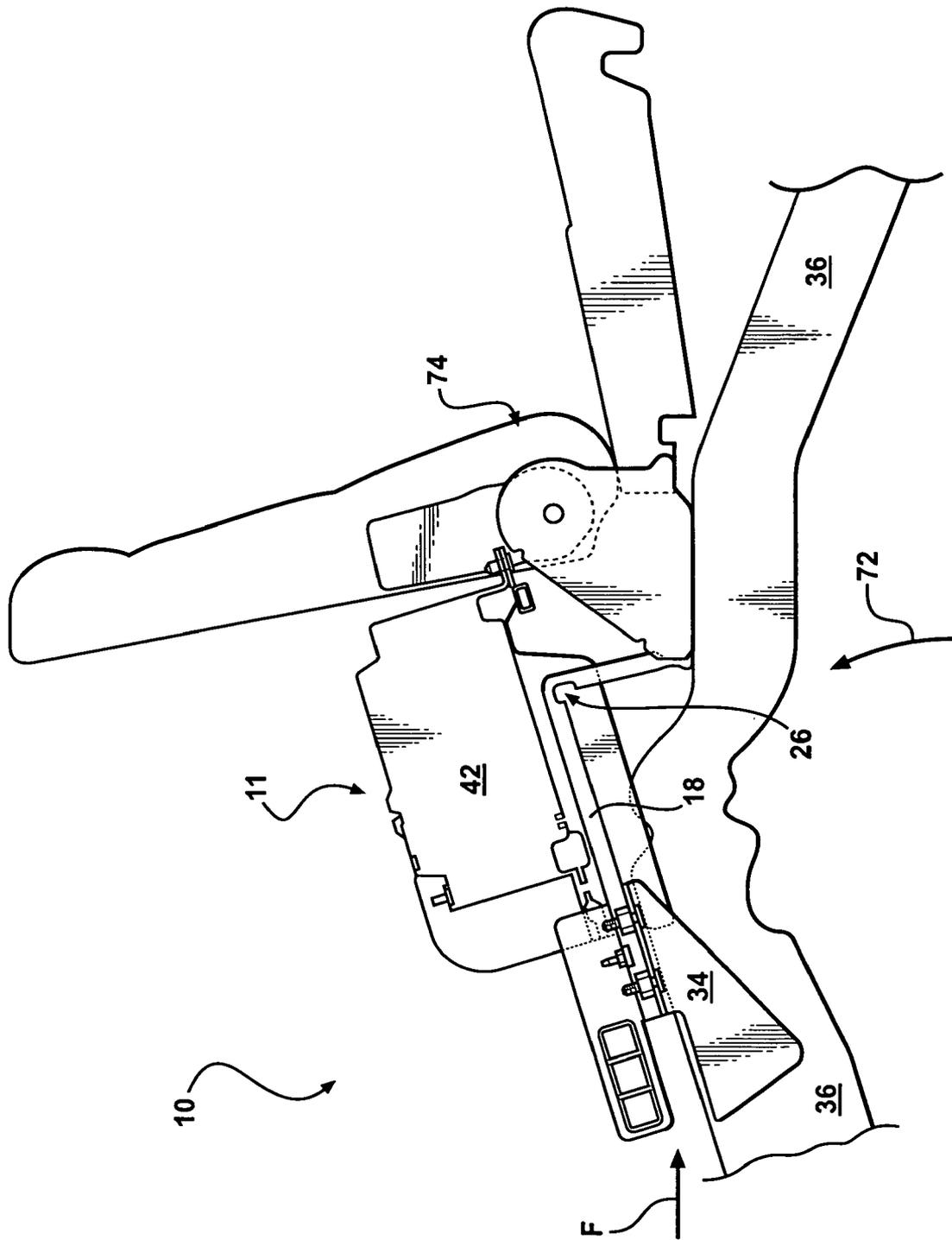


FIG - 3

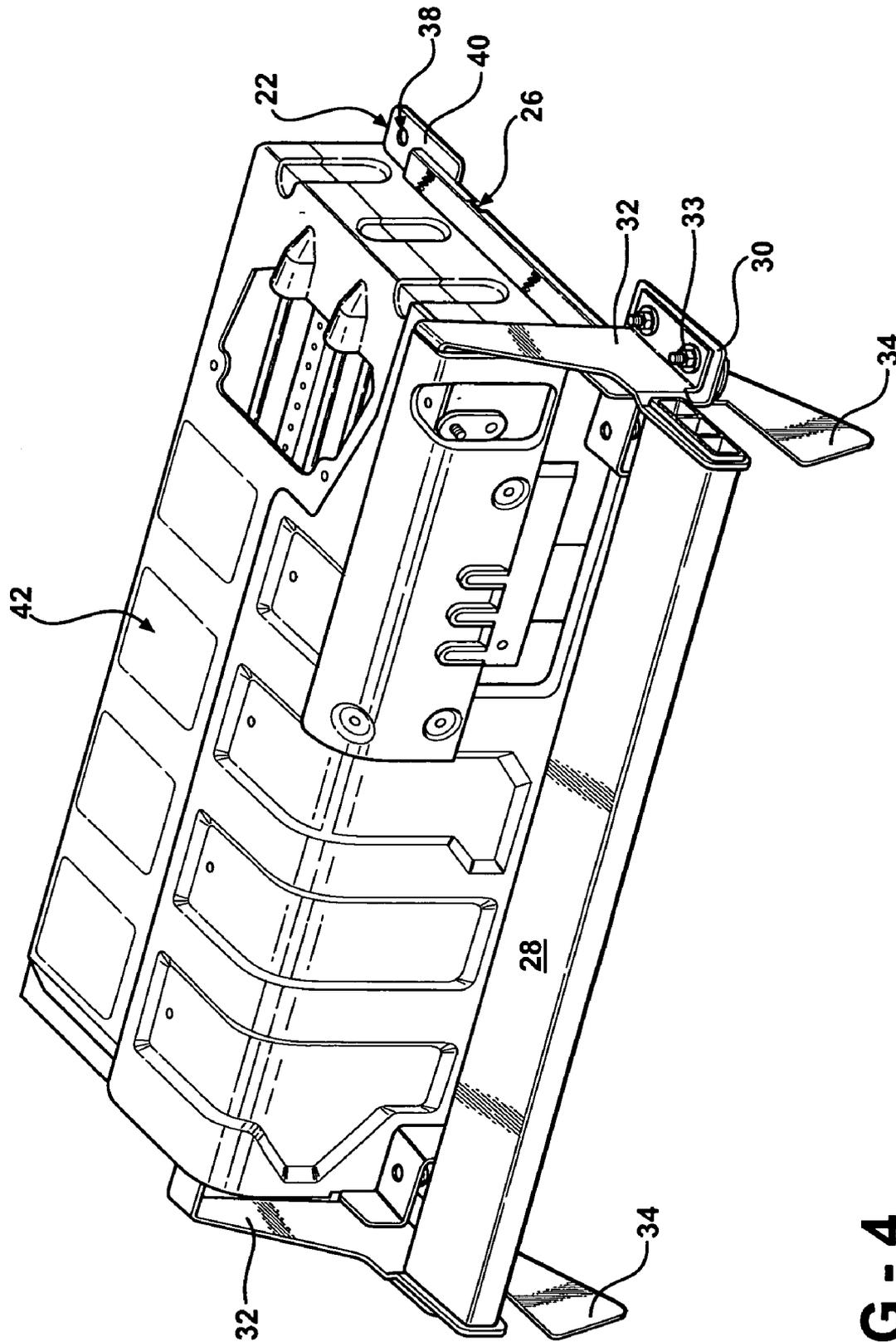


FIG - 4

**DEFORMABLE COMPONENT CARRIER**

## BACKGROUND OF THE INVENTION

The present invention relates generally to automotive vehicle structures and, in particular, to a deformable component carrier for supporting a component in a vehicle structure.

Certain portions of the structure of automobile vehicles are designed to crush in order to absorb energy during a crush event, i.e., when a force exceeding a predetermined value is applied to the vehicle structure. As new and different components are mounted to the vehicle structure, these components must be accounted for in the design of the vehicle structure in the case of a crush event.

It is desirable, therefore, to provide a carrier that supports a component and allows the vehicle structure to absorb energy in a normal manner during a crush event.

## SUMMARY OF THE INVENTION

The present invention concerns a carrier for use in supporting a component in a vehicle structure. The carrier includes at least a pair of side rails each having a first end and an opposed second end. The first and second ends of the side rails are attached to the vehicle structure, and each side rail includes a predetermined bending location at a predetermined location between the first and second ends. The component is adapted to be attached to the side rails intermediate the predetermined bending location and the first end. The side rails are operable to bend about the predetermined bending location when an impact load is applied to the first end of the side rails.

Preferably, the side rails are sacrificial side rails and the carrier includes a cross member attached to each of the first ends of the side rails. Preferably, the carrier includes a perimeter rail assembly attached to the side rails intermediate the predetermined bending location and the first end that is adapted to support the component. The perimeter rail assembly is particularly advantageous for mounting those components that require additional vertical support during a crush event or the like and where it is not desirable for the component to sustain any crush itself during the crush event. The component may be, but is not limited to, a fuel cell, a high voltage hybrid vehicle battery, or the like.

In operation, when a force, such as a vehicle impact or the like, is applied to the cross member or the first ends of the carrier, the side rails bend about the predetermined bending location and lift the component up and away from the crush event.

The carrier in accordance with the present invention allows a component to be attached to a vehicle, such as to a vehicle frame rail or the like, and allows the vehicle frame rail to function as intended during a rear impact or crush event without requiring extensive redesign of the properties of the frame rail. The carrier allows the frame rail to crush while moving the component out of the direction of the crush.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings in which:

FIG. 1 is a perspective view of an carrier in accordance with the present invention;

FIG. 2 is a side view of the carrier of FIG. 1 shown mounted to a vehicle frame and with a component attached thereto in an undeformed position;

FIG. 3 is a side view of the apparatus, component, and vehicle frame of FIG. 2 shown in an deformed position after a crush event; and

FIG. 4 is a perspective view of the apparatus of FIG. 1 shown with a component attached thereto.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1–4, a carrier in accordance with the present invention is indicated generally at 10. The carrier 10 includes a first side rail 12 having a first end 14 and an opposed second end 16 and a second side rail 18 having a first end 20 and an opposed second end 22. The side rails 12 and 18 are preferably substantially equal in length and are constructed of a high strength steel, a high strength steel alloy, or similar high strength material and are preferably formed tubular in cross section to reduce the overall weight of the rails 12 and 18. The first side rail 12 includes a predetermined bending location, indicated generally at 24, intermediate the first end 14 and the second end 16 thereof. The second side rail 18 includes a predetermined bending location, indicated generally at 26, intermediate the first end 20 and the second end 22 thereof. The distance between the first end 14 and the predetermined bending locations 24 is preferably equal to the distance between the first end 20 and the predetermined bending location 26 but this may vary depending on the shape and orientation of the particular component, discussed in more detail below, being mounted thereto. The predetermined bending locations 24 and 26 are preferably structural notches formed in a lower surface of the respective side rails 12 and 18, best seen in FIG. 2. The predetermined bending locations 24 and 26 preferably define an arcuate-shaped notch in the lower surface of the rails 12 and 18. The predetermined bending locations 24 may also define any other shape advantageous for bending the rails 12 and 18 in the desired manner during a crush event, discussed in more detail below. The notch defines a lower strength or weakened cross sectional area of the rails 12 and 18, which allow the rails 12 and 18 to bend about the bending locations 24 and 26, discussed in more detail below.

A cross member 28 extends between and is fixedly attached at opposing ends thereof to the respective first ends 14 and 20 of the side rails 12 and 18. The cross member 28 is preferably constructed of high strength steel, a high strength steel alloy, or similar high strength material and is preferably formed tubular in cross section to reduce the overall weight of the cross member 28. The cross member 28 is preferably fixedly attached to the respective first ends 14 and 20 of the side rails 12 and 18 by welding or other robust attachment means known to those skilled in the art. The cross member 28 includes a pair of outwardly extending flanges 30 formed integrally with and extending outwardly from the opposing ends of the cross member 28. The flanges 30 are each adapted to attach the opposing ends of the cross member 28 to a vertical support member 32 on an upper surface thereof, such as with the use of fasteners or bolts 33 extending through apertures (not shown) formed in the flanges 30 and the vertical support member 32. The vertical support members 32 provide lateral support to a component 42, best seen in FIGS. 2–4, when the component 42 is attached to the carrier 10, discussed in more detail below. A

pair of downwardly extending frame attachment members **34** are attached to a lower surface of the flanges **30**, such as with the use of fasteners or bolts extending through apertures (not shown) formed in the flanges **30** and the frame attachment members **34**. Preferably, the bolts **33** are utilized to attach both the vertical support members **32** and the frame attachment members **34** to the flanges **30**. A free end of each of the frame attachment members **34** is adapted to be welded to a vehicle frame rail **36** (or other vehicle structure that may crush during a crush event), best seen in FIGS. **2** and **3**.

The second ends **16** and **22** of the side rails **12** and **18** are each adapted to be attached to a vehicle body, such as to the vehicle frame rail **36**, and best seen in FIGS. **2** and **3**. Preferably, the second ends **16** and **22** are rigidly attached to the vehicle frame rail **36**, such as by bolts (not shown) extending through apertures **38** formed in a flange **40**, best seen in FIG. **1**, on the second ends **16** and **22**, by welding or other attachment or fastening means known to those skilled in the art.

The component **42**, best seen in FIGS. **2-4**, is adapted to be attached to the side rails **12** and **18**. The component **42** may be a high voltage battery for a hybrid electric vehicle, a fuel cell, or any other component that is desirable to move from the path of a crush event of the vehicle. The component **42** is adapted to be supported by or attached to the side rails **12** and **18** intermediate the predetermined bending location **24** and the first end **14** and intermediate the predetermined bending location **26** and the first end **20**, respectively. The component **42** is attached to the side rails at a rear attachment point **44** adjacent the first end **14** of the first side rail **12** and a rear attachment point **46** adjacent the first end **20** of the second side rail **18**. The attachment points **44** and **46** are preferably inwardly extending flanges having apertures (not shown) extending therethrough for receiving a fastener such as a bolt **48** or the like to secure the component **42** thereto.

The carrier **10** preferably includes a perimeter rail assembly, indicated generally at **50**. The perimeter rail assembly **50** includes a first side support **52** having a rearward end **54** and a forward end **56**, a second side support **58** having a rearward end **60** and a forward end **62**, and a transverse front support **64** connecting the first side support **52** and the second side support **58** adjacent the forward end **56** and the forward end **62**. The first side support **52**, the second side support **58**, and the transverse front support **64** are preferably constructed of high strength steel, a high strength steel alloy, or similar high strength material and are preferably formed tubular in cross section to reduce the overall weight of the perimeter rail assembly **50**. The transverse front support **64** is preferably attached to the first side support **52** and the second side support **58** by welding or similar attachment known to those skilled in the art. The rail assembly **50** is adapted to be attached to the carrier **10** rearward of the predetermined bending locations **24** and **26**, such as by welding the first side support **52** to the first side rail **12** between the rearward portion **54** to a location **64** adjacent the predetermined bending location **24** and welding the second side support **58** to the second side rail **18** between the rearward portion **60** to a location **66** adjacent the predetermined bending location **26**. The perimeter rail assembly **50** includes a plurality of forward attachment locations **68** for attaching the component **42** to the perimeter rail assembly **50**. The attachment points **68** are preferably forwardly extending flanges having apertures (not shown) extending therethrough for receiving a fastener such as a bolt **70** or the like to secure the component **42** thereto.

In operation, the forward end of the carrier **10** is attached to the vehicle frame rail **36** at the second ends **16** and **22** of the side rails **12** and **18**, and the rear end of the carrier **10** is attached to the vehicle frame rail **36** at the frame attachment members **34**. The component **42** is attached to the carrier **10** at the rear attachment points **44** and **46**. A forward portion of the component **42** is then placed on or attached to an upper surface of the side rails **12** and **18** or attached to the forward attachment points **68** of the perimeter rail assembly **50**. The component **42** and the carrier **10**, when attached, form a carrier assembly, indicated generally at **11**.

During operation of the vehicle, a force, indicated by an arrow **F** in FIGS. **2** and **3**, is applied to the vehicle frame rail **36**, such as during a rear impact event or the like. The force **F** is transferred from the vehicle frame rail **36** to the cross member **28** through the frame attachment members **34** and to the side rails **12** and **18** through their respective fixed connections to the cross member **28**. If the force **F** is greater than a predetermined value (i.e., a force sufficient to initiate a crush event), the vehicle frame rail **36** begins to buckle, crumple, or crush, best seen in FIG. **3**, and the length of the vehicle frame rail **36** begins to shorten from the end adjacent the cross member **28**. The design of the vehicle frame rail **36** is such that it will shorten or crush a predetermined distance based on the amount of energy of the force **F** and reduce the amount of the force **F** that is transferred to the passenger compartment of the vehicle. Because the side rails **12** and **18** are attached to the vehicle frame rail **36** through the cross member **28**, the side rails **12** and **18** also begin to move toward the second ends **16** and **22** of the side rails **12** and **18**.

As this length shortening occurs, the side rails **12** and **18** begin to bend about the predetermined bending locations **24** and **26** because the cross sectional area defined by the structural notch at the locations **24** and **26** is weaker than the remainder of the respective rails **12** and **18** due to the location and orientation of the bending locations **24** and **26**. The side rails **12** and **18** bend in a direction indicated by an arrow **72**, best seen in FIG. **3**, from the undeformed position shown in FIG. **2** to the deformed position shown in FIG. **3**. Because the component **42** is only attached to the carrier **10** intermediate the predetermined bending location **24** and the first end **14** of the first side rail **12** and intermediate the predetermined bending location **26** and the first end **20** of the second side rail **18**, as the side rails **12** and **18** bend in the direction **72**, the component **42** is lifted in the direction **72** up and away from the second ends **16** and **22** of the side rails **12** and **18**. By lifting the component **42** in the direction **72**, the component **42** does not interfere with the crush of the vehicle frame rail **36**, the components **42** itself does not sustain crush, nor does the component **42** interfere with components in the interior of the vehicle, such as a vehicle seat **74**, best seen in FIGS. **2-3**. The cross member **28** acts as a barrier during a crush event, thus minimizing contact between other components (not shown) that may be attached to the vehicle frame rail **36** rearward of the carrier **10**.

The carrier **10** in accordance with the present invention allows the vehicle frame rail **36** to shorten or crush the predetermined distance while absorbing energy during a crush event without requiring a redesign of the vehicle frame rail **36**. The side rails **12** and **18** of the carrier **10** act as sacrificial members during a crush event, as the side rails **12** and **18** are deformed while the component **42** remains essentially intact during the crush event. The carrier **10** allows a component **42** to be placed in a vehicle structure, such as the vehicle frame rail **36**, and moves the component **42** up and away from the vehicle frame rail during a crush

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event, allowing the vehicle frame rail 36 to absorb the predetermined amount of energy.

The respective distance between the first ends 14 and 20 and the predetermined bending locations 24 and 26 is determined by the anticipated load to be applied to the cross member 28 and the predetermined crush distance and predetermined amount of energy to be absorbed by the vehicle frame rail 36. The relative size and/or the shape of the structural notch at the predetermined bending locations 24 and 26 may be selected to bend at a predetermined load applied to the respective first ends 14 and 20 of the side rails 12 and 18. While the carrier 10 has been shown as having a pair of side rails 12 and 18, those skilled in the art will appreciate that more or fewer sacrificial side rails may be a part of the carrier 10 while remaining within the scope of the present invention.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.

The invention claimed is:

1. A carrier for use in supporting a component in a vehicle structure, comprising:

- at least a pair of side rails each having a first end and an opposed second end, with said first and second ends attached to the vehicle structure, and with each said side rail including a predetermined bending location at a predetermined location between said first and second ends, said component adapted to be attached to said side rails intermediate said predetermined bending location and said first end, said side rails operable to bend about said predetermined bending location when said vehicle structure crushes between said first ends and said second ends; and
- a cross member extending between said first ends of said side rails.

2. The carrier according to claim 1 wherein said predetermined bending locations are structural notches formed intermediate said first and second ends.

3. The carrier according to claim 2 wherein said structural notches are substantially arcuate in cross section.

4. The carrier according to claim 1 wherein said component is attached to said carrier at at least one mounting location adjacent said first ends of said side rails.

5. The carrier according to claim 1 including at least one vertical support member attached to said cross member.

6. The carrier according to claim 5 including a perimeter rail assembly attached to said side rails intermediate said predetermined bending location and said first end, said perimeter rail assembly adapted to mount the component thereon.

7. The carrier according to claim 6 wherein said perimeter rail assembly includes a first side support having a rearward and a forward end, a second side support having a rearward and a forward end and spaced from the first side support, and a transverse front support connected between the first and second side supports adjacent to the forward ends.

8. The carrier according to claim 1 including at least one frame attachment member attached to said cross member.

9. The carrier according to claim 8 including a perimeter rail assembly attached to said side rails intermediate said

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predetermined bending location and said first end, said perimeter rail assembly adapted to mount the component thereon.

10. The carrier according to claim 9 wherein said perimeter rail assembly includes a first side support having a rearward and a forward end, a second side support having a rearward and a forward end and spaced from the first side support, and a transverse front support connected between the first and second side supports adjacent to the forward ends.

11. The carrier according to claim 1 including a perimeter rail assembly attached to said side rails intermediate said predetermined bending location and said first end, said perimeter rail assembly adapted to mount the component thereon.

12. The carrier according to claim 11 wherein said perimeter rail assembly includes a first side support having a rearward and a forward end, a second side support having a rearward and a forward end and spaced from the first side support, and a transverse front support connected between the first and second side supports adjacent to the forward ends.

13. The carrier according to claim 1 wherein said opposed ends of said side rails are attached to a vehicle frame rail.

14. A carrier for use in supporting a component in a vehicle structure, comprising:

- at least a pair of side rails each having a first end and an opposed second end, with said first and second ends attached to the vehicle structure, and with each said side rail including a predetermined bending location at a predetermined location between said first and second ends, said component adapted to be attached to said side rails intermediate said predetermined bending location and said first end, said side rails operable to bend about said predetermined bending location when said vehicle structure crushes between said first ends and said second ends; and
- a perimeter rail assembly attached to said side rails intermediate said predetermined bending location and said first end, said perimeter rail assembly adapted to mount the component thereon.

15. The carrier according to claim 14 wherein said predetermined bending locations are structural notches formed intermediate said first and second ends.

16. The carrier according to claim 15 wherein said structural notches are substantially arcuate in cross section.

17. The carrier according to claim 14 wherein said component is attached to said carrier at at least one mounting location adjacent said first ends of said side rails.

18. The carrier according to claim 14 wherein said perimeter rail assembly includes a first side support having a rearward and a forward end, a second side support having a rearward and a forward end and spaced from the first side support, and a transverse front support connected between the first and second side supports adjacent to the forward ends.

19. The carrier according to claim 14 wherein said opposed ends of said side rails are attached to a vehicle frame rail.